DOE Transmission Reliability Program Peer Review

CERTS MicroGrid

Bob Lasseter

University of Wisconsin-Madison

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CONSORTIUM FOR ELECTRIC RELIABILITY TECHNOLOGY SOLUTIONS

Distributed technologies

- Seamlessly **integrate distributed technologies** – including technologies for generation, storage, controls, and communications – to support the reliability and power quality needs of both the grid and customers

- Current focus: **MicroGrid paradigm & its control and protection**

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Key DG Issues

Substation DG

Combustion Turbine, Fuel Cells
Reciprocating Engines,

- **1-10 MW: 2.2 kV & up**
- **Higher Emissions**
- **Lower Losses**
- **Difficult to use Waste Heat**
- **Dispatchable**

"Appliance like" DG

Microturbine, Photovoltaic,
Automotive Fuel Cells

- **~100 kW: 120-480 V**
- **Lower Emissions**
- **Close to Loads**
- **Can use Waste Heat**
- **Difficult to Dispatch**
- **Power Electronic Interface**

What is a MicroGrid?

"Electrical subsystem which combines DG with loads and provides a controlled single point of connection to the grid/or operates isolated."

Nick Miller: General Electric

"Small power system which can be operated independently of the bulk power system."

Doug Herman: EPRI

"Local scale power system using micro-source generation scaled either by electrical or thermal output to the local system demand."

Jonathan Lynch: Northern Power Systems

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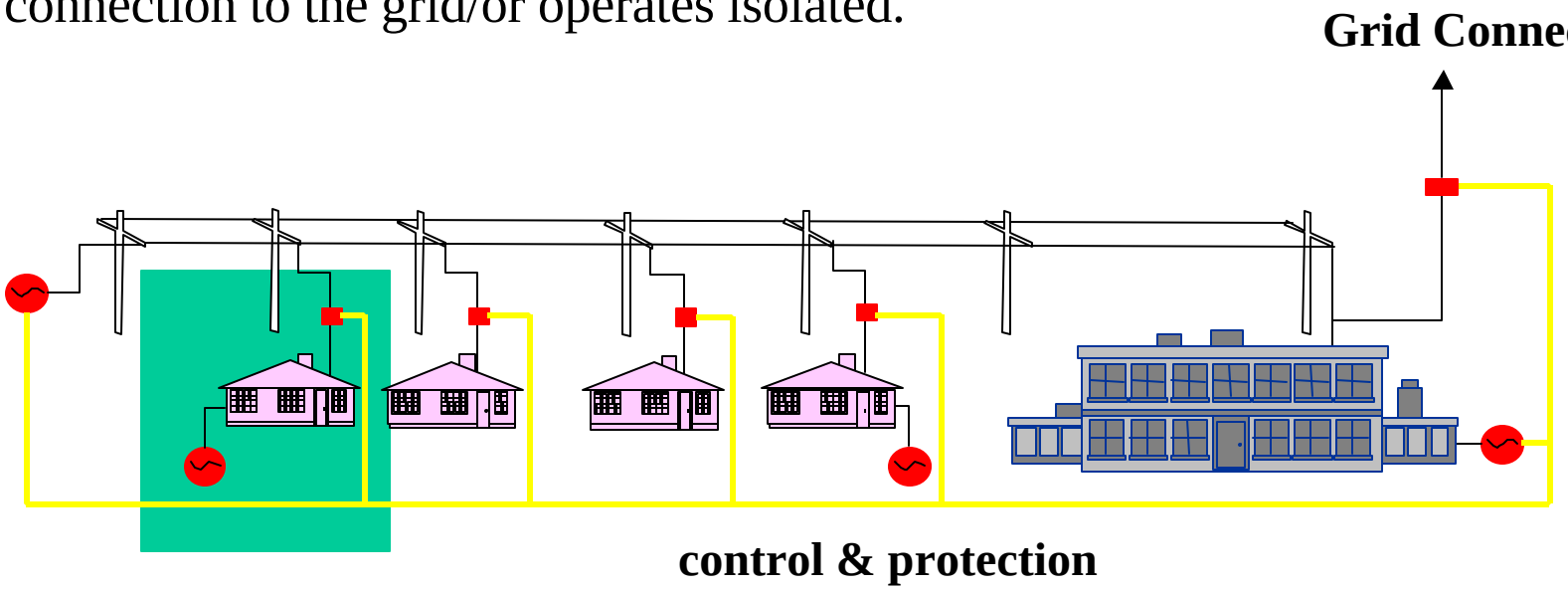
GE: AC Microgrid

"Electrical subsystem which combines DG with loads and provides a controlled single point of connection to the grid/or operates isolated."



Issues:

- Load tracking
- Fast central control

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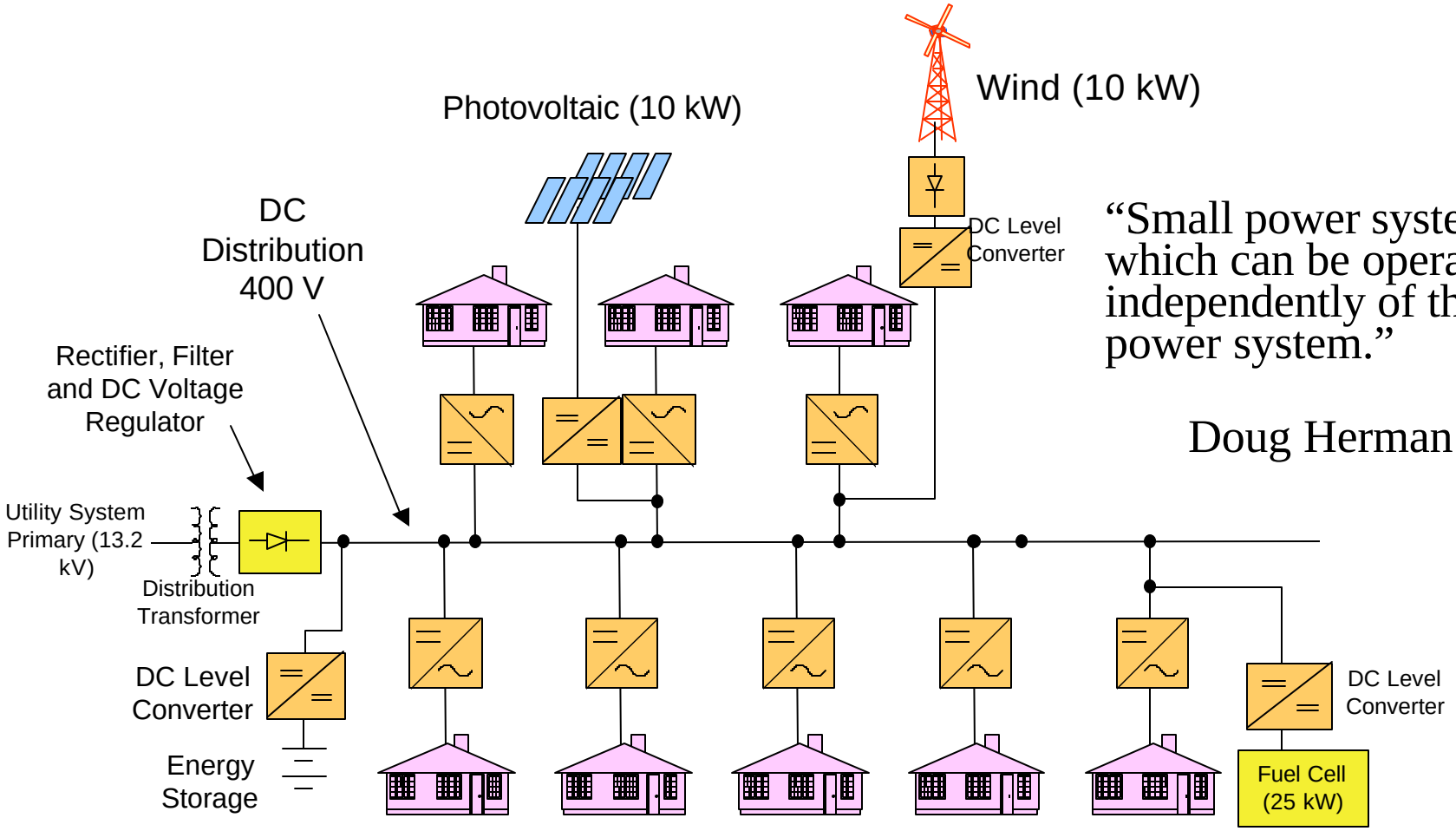
EPRI: DC Microgrid



"Small power system which can be operated independently of the bulk power system."

Doug Herman: EPRI

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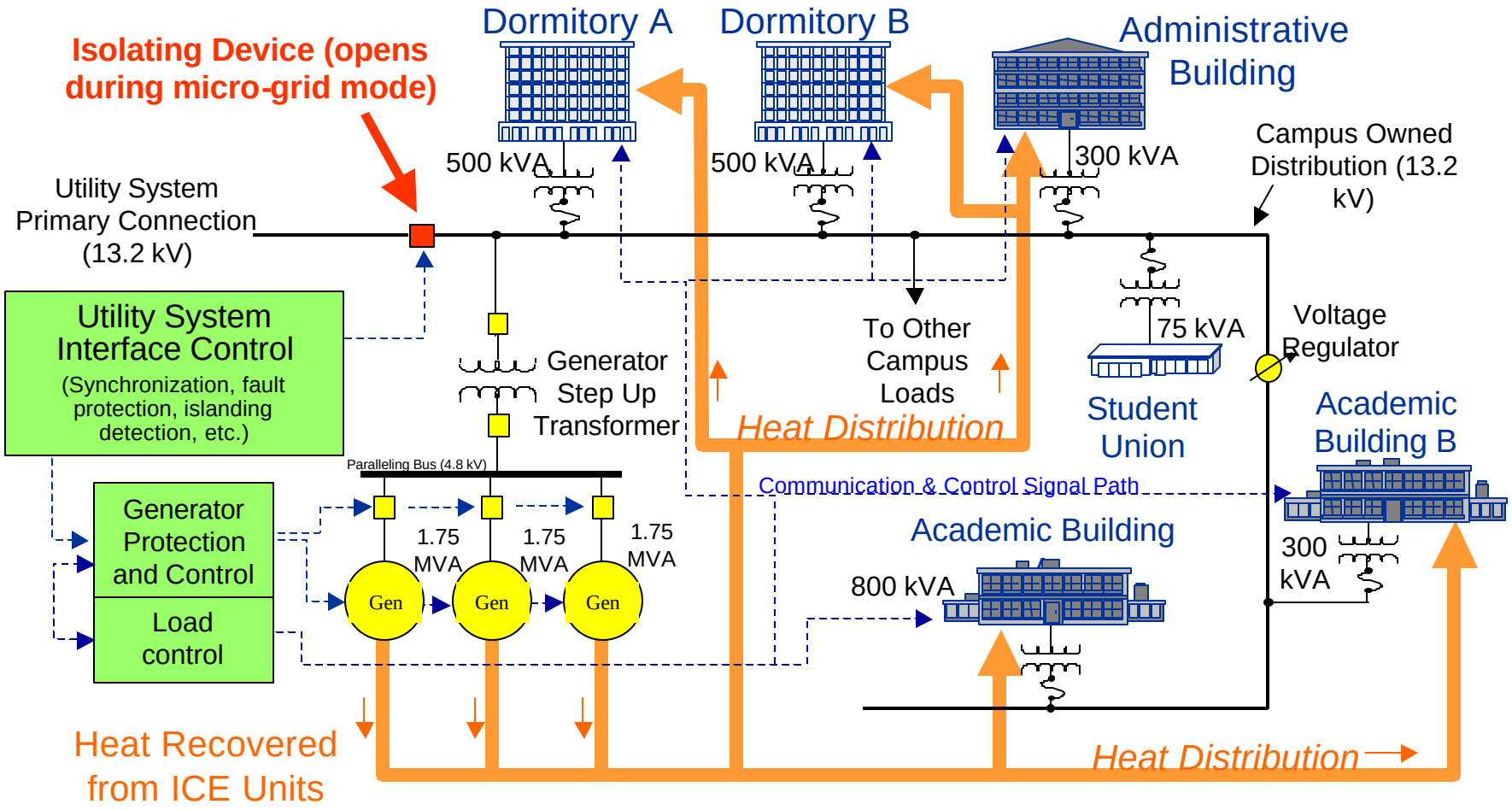
EPRI: Campus Microgrid System



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Key DG Issues

Substation DG Combustion Turbine, Fuel Cells Reciprocating Engines,	"Appliance like" DG Microturbine, Photovoltaic, Automotive Fuel Cells
• 1-10 MW: 2.2 kV & up	• ~100 kW: 120-480 V
• Higher Emissions	• Lower Emissions
• Lower Losses	• Close to Loads
• Difficult to use Waste Heat	• Can use Waste Heat
• Dispatchable	• Difficult to Dispatch
	• Power Electronic Interface

What do we want from MicroGrids?

- Support high penetration levels of microsources
- Provide value to both the customer and the bulk power provider
- Insure stable & reliable operation
- Provide placement flexibility for CHPs
- Satisfy IEEE 1547
- Minimal centralized control
- Simplify the system design (plug-and-play)
- Lower total cost

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CERTS MicroGrid Paradigm

MicroGrid concept assumes a cluster of loads and micro-sources operating as a single system which provides both power and heat.

- **Present itself to the bulk power system as a single controlled unit**
- **Meets customers needs for reliability and security**

The majority of the microsources must be power electronic based to provide the plug & play flexibility.

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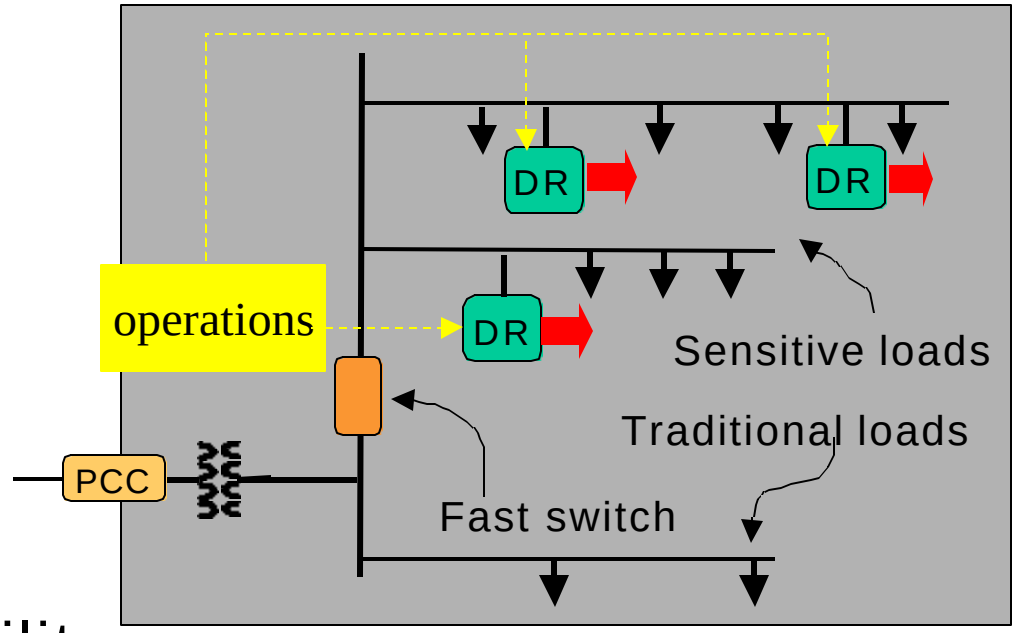
CERTS MicroGrid



Customer

- Local voltage control
- UPS functions
- Loss reduction
- Local redundancy
- Use of waste heat

Utility

- Dispatchable load
- Real-time pricing
- OK - 1547

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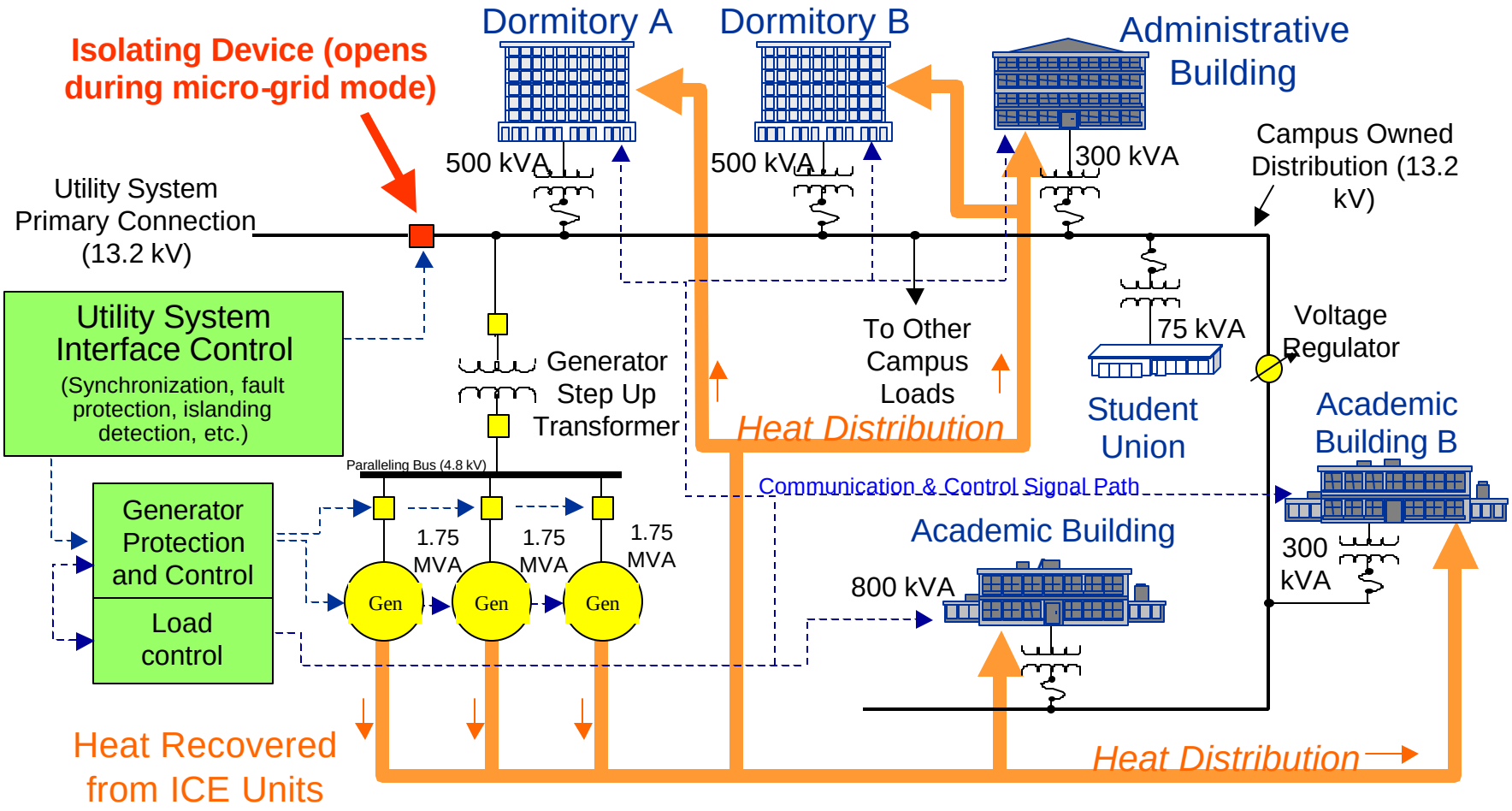
Consortium for Electric Reliability Technology Solutions

EPRI: Campus Microgrid System



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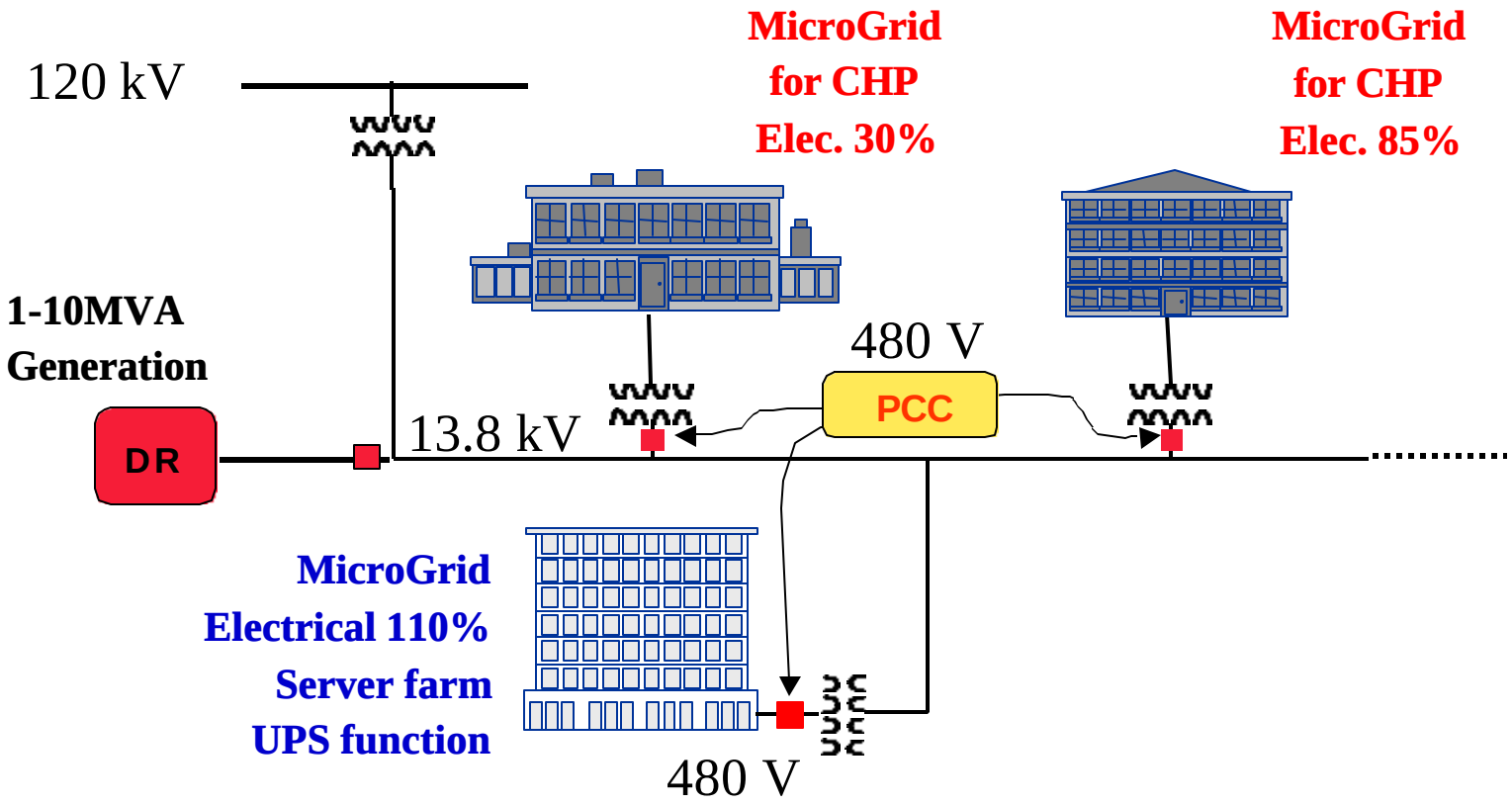
Beyond CERTS MicroGrid



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MicroGrid: Research Issues

Power electronics control

- Voltage control
- Power flow control
- Power sharing during island operation

Protection

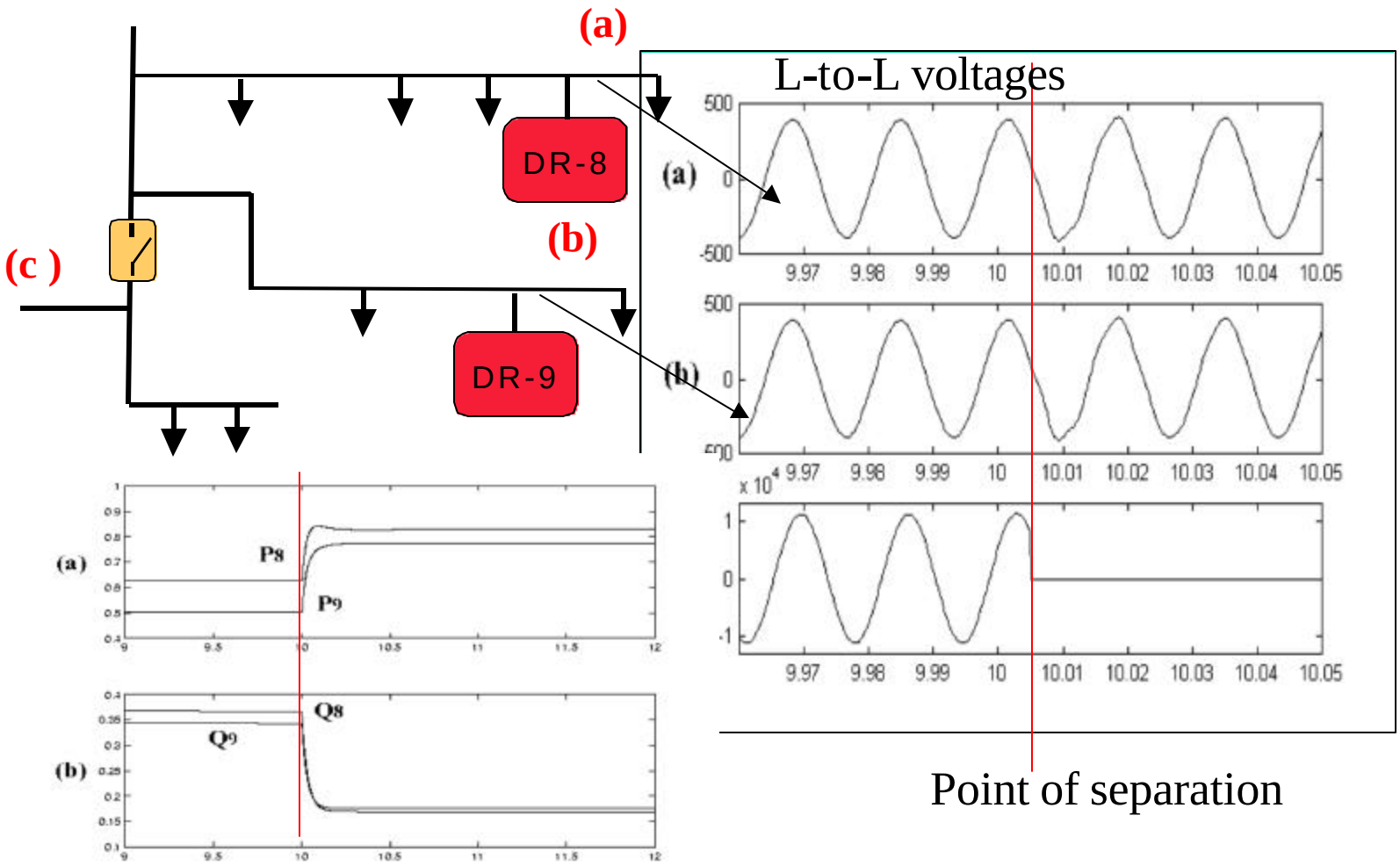
- Low short circuit currents
- Islanding and resynchronization

CHP

Operation

Tools

Islanding: Power sharing



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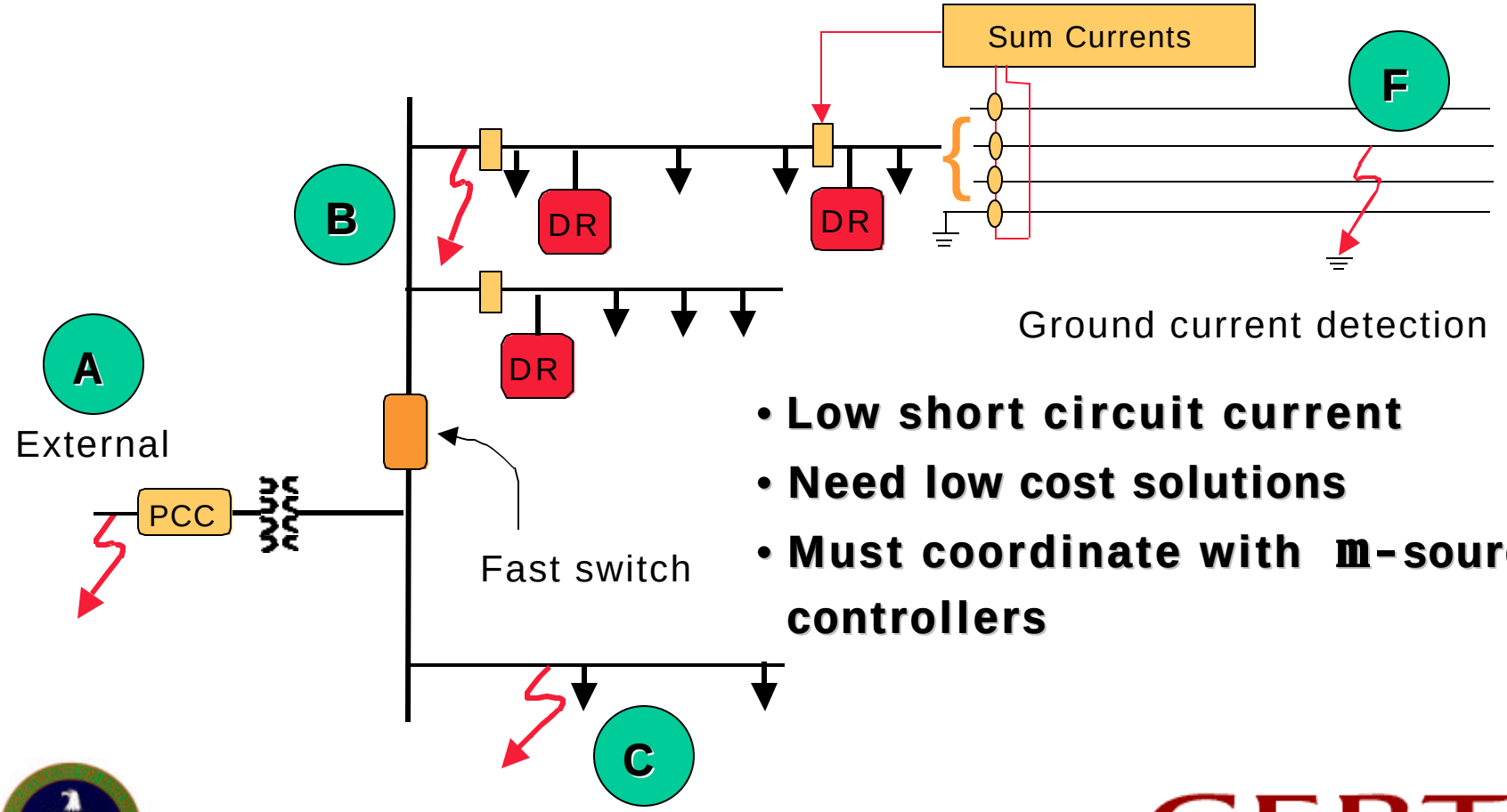
Protection



- **Low short circuit current**
- **Need low cost solutions**
- **Must coordinate with m-source controllers**

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Combined Heat & Power:

Heat production close to point of use

- Smallness of individual units
- Waste heat temperatures
- Availability of heat exchangers
- Extra cost

MicroGrid Operation

The actual values of dispatch of P and V to each microsource depends on the operational needs of the MicroGrid. Some possible criteria are:

- Insure that the necessary heat and electrical loads are met by the microsources;
- Insure that the MicroGrid satisfies operational contracts with the bulk power provider;
- Minimize emissions and/or system losses;
- Maximize the operational efficiency of the microsources;
- Minimize cost; and
- Et cetera

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Conclusion on Protection & Control

Current Research Activities

- Completed simulations on controls
- Designed protection concepts

New Research Activities

- Test in hardware
- Field demonstration

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